

# Geographies of Health, Disease, and Well-being

Recent Advances in Theory and Method

*Edited by*  
**Mei-Po Kwan**



# Geographies of Health, Disease, and Well-being

This book is a collection of papers reflecting the latest advances in geographic research on health, disease, and well-being. It spans a wide range of topics, theoretical perspectives, and methodologies – including anti-racism, post-colonialism, spatial statistics, spatiotemporal modeling, political ecology, and social network analysis. Health issues in various regions of the world are addressed by interdisciplinary authors, who include scholars from epidemiology, medicine, public health, demography, and community studies. The book covers the major themes in this field such as health inequalities; environmental health; spatial analysis and modeling of disease; health care provision, access, and utilization; health and well-being; and global/transnational health and health issues in the global south. There is also a specially commissioned book review in addition to the chapters included in these six sections. Together, these chapters show cogently how geographic perspectives and methods can contribute in significant ways to advancing our understanding of the complex interactions between social and physical environments and health behaviors and outcomes.

This book was published as a special issue of *Annals of the Association of American Geographers*.

**Mei-Po Kwan** is Professor of Geography and Geographic Information Science at the University of Illinois at Urbana-Champaign. A health/urban geographer with a focus on environmental health, mobility and health, and application of advanced geospatial methods in health research, she has received many prestigious research awards and garnered substantial research support from sources including the National Institutes of Health and the National Science Foundation.

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# Geographies of Health, Disease, and Well-being

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In the past two decades or so, geographers and researchers in cognate disciplines have significantly advanced our understanding of the geographies of health, disease, and well-being in different areas of the world (e.g., Gatrell and Elliott 2009; Brown, McLafferty and Moon 2010; Meade and Emch 2010; Pearce and Witten 2010). Various theoretical perspectives and geographic methods have been applied to study health issues (e.g., Kearns 1993; Dorn and Laws 1994; Elliott et al. 2000; Andrews and Evans 2008; Cromley and McLafferty 2011). Importantly, health scholars have re-asserted the roles of environment, place, context, and neighborhood as significant influences on health behaviors and outcomes (e.g., Jones and Moon 1993; Diez Roux 1998, 2001; Curtis and Jones 1998; Macintyre, Ellaway, and Cummins 2002; Kawachi and Berkman 2003; McLafferty 2008; Nemeth et al. 2012). It is now widely recognized that geographic variations in health, disease, and well-being cannot be explained exclusively in terms of the characteristics of individuals, as specific characteristics of place or neighborhoods (e.g., collective efficacy) also exert significant influence on health.

The fourth annual special issue of the *Annals of the Association of American Geographers* focuses on the geographies of health, disease, and well-being. The call for abstracts was issued in early 2010, and review of full papers and revised submissions lasted from December 2010 to March 2012. Papers were sought to address social, cultural, political, environmental, theoretical, and methodological issues related to health, disease, and well-being, including topics such as access to health care, spatial disparities in health outcomes, the effect of geographic context on health outcomes, mobility and health, environmental health, development and health, space-time modeling and geographic information systems (GIS)-based analysis of health outcomes. The purpose of the annual special issues is to publish articles that reflect the range of research contributions of geographers and scholars in cognate disciplines to contemporary issues of significant social relevance. They seek to highlight the work of geographers around an important global theme and publish articles covering a wide spectrum of the discipline in a format accessible to a wide range of readers.

The articles in the special issue (and this book) reflect some of the latest theoretical and methodological advances in geographic research on health, disease, and well-being.<sup>1</sup> They span a wide range of topics, theoretical approaches, and methodologies (e.g., anti-racism, post-colonialism, spatial statistics, political ecology, nature-society perspectives, biopolitics, spatial cluster analysis, social network analysis, governability, and spatial-temporal modeling). Many of them are highly interdisciplinary, involving researchers from disciplines like epidemiology, medicine, public health, demography, and community studies. Health issues in about fourteen countries are addressed (Bangladesh, Belize, Canada, Cuba, Ghana, India, Kenya, Mexico, Netherlands, New Zealand, South Africa, Taiwan, U.K., U.S.)

The thirty-four main chapters in this book are organized in six sections according to their main themes and the nature of their contribution: (1) health inequalities (five articles); (2) environmental health (seven articles); (3) spatial analysis and modeling of disease (seven articles); (4) health care provision, access, and utilization (seven articles); (5) health and well-being (four articles); and (6) global/transnational health and health issues in the Global South (four articles). There is also a specially commissioned book review by Melinda Meade in addition to the thirty-four main chapters. This organization, however, should be understood largely as a heuristically derived scheme, as many of the chapters address issues that cross-cut the themes of several sections and thus cannot be unproblematically assigned to any one section (e.g., McLafferty et al. (Chapter 2) and Weeks et al. (Chapter 6) examine issues of health disparities in transnational contexts; Messina et al. (Chapter 17) investigate environmental health through dynamic spatial models).

Investigations of *health inequalities* and their social and policy implications have been an important research theme in public health for decades. The five chapters on health inequalities highlight how

geographic processes and factors affect the health and well-being of various social groups. Using a GIS-based ethnic density measure (kernel density estimation) and spatial data on mothers' residential locations, McLafferty et al. (Chapter 2) examine infant health inequalities in New York City. The study found that in 2000, Bangladeshi immigrant women living in isolated settings and those in the highest ethnic density areas are vulnerable to poor infant health outcomes. Based on interviews with members of First Nations communities in the northern interior region of British Columbia in Canada, de Leeuw et al. (Chapter 3) found that colonial geographies and anti-Indigenous racism are important determinants of the health and well-being of the Indigenous people who live on Indian reserves in the region.

Using census data of New Zealand geocoded to local and urban area levels and multilevel modeling, Moon, Pearce, and Barnett (Chapter 4) observe that individual ethnic status and area-level deprivation are important factors shaping people's smoking behavior. Grady and Darden (Chapter 5) examine the relationship between local racial residential segregation and infant health in Detroit, Michigan. The study found persistent effects of racial residential segregation and socioeconomic neighborhood inequality on the health of black women and their low birth weight infants when compared to white women. Using satellite imagery and census and survey data, Weeks et al. (Chapter 6) investigate the spatial and health characteristics of cities in Accra, Ghana and observe that local levels of health and well-being are closely related to the abundance of vegetation in a neighborhood.

Research on *environmental health* seeks to assess the influence of physical and social environments on health outcomes or behaviors. Seven chapters address this theme. Lam (Chapter 7) addresses the need to reduce errors and uncertainties in environmental health risk assessment. She identifies four major sources of uncertainties (data, methods of analysis, interpretations of the findings, and reactions to the findings) and discusses five groups of geospatial methods that can help reduce these uncertainties. Focusing particularly on studies that examine the effects of area-based attributes on individual behaviors or outcomes, Kwan (Chapter 9) articulates a fundamental methodological problem that can confound research results in significant ways: the *uncertain geographic context problem* (UGCoP). The chapter clarifies the nature and sources of the problem, highlights some of the inferential errors it may cause, and discusses some means for mitigating the problem. Together these two chapters discuss many important methodological issues pertinent to the study of environmental health.

Guthman (Chapter 8) and Mansfield (Chapter 10) assert the importance of the human body as a lens through which new insights about environmental health can be gained. Through a critical political ecology perspective, Guthman argues that investigations of the relationship between urban form and obesity tend to "black-box the biological body as the site where excess calories are putatively metabolized into fat and made unhealthy." The chapter highlights some anomalies not well explained by current geographic approaches and discusses evidence from emerging biomedical research that questions these approaches to examining the relationship between obesity and health. Informed by the Foucauldian perspective of biopolitics, Mansfield interrogates current approaches in public health research on contaminated seafood. She argues that the "dominant approach is one in which risk is used to secure the population by calculating the net benefits and hazards of women's seafood consumption," with the intention to influence women's seafood choices.

Using three case studies as evidence, Scott, Robbins, and Comrie (Chapter 11) illustrate the coevolution dynamics of pathogen ecologies and human institutions. The study shows that mutual influence between humans and pathogens is significantly mediated by the motives and responses of individuals and institutions, and investigations of place-based contextual exposure provide only a partial explanation of disease transmission. Using data on birth defects in North Carolina, Root (Chapter 12) examines the geographic relationship between socioeconomic status (SES) and orofacial clefts (cleft lip and cleft palate) at different spatial scales. As an attempt to explore geographic and statistical methods for mitigating the modifiable areal unit problem (MAUP), the study illustrates how researchers can identify the best neighborhood size for examining such relationship using the Brown–Forsythe test. Groenewegen et al. (Chapter 13) report findings from a research program that examines the relationships between greenspace and health, focusing on three particular mechanisms: physical activity, stress reduction, and social cohesion. The results, as the authors elaborate, indicate that both the quantity and quality of greenspace in residential areas have positive impacts on people's health (more because of stress reduction and social cohesion than physical activity).

The seven chapters on *spatial analysis and modeling of disease* showcase important advances in geographic methods for health research, and several of them focus on the spatiotemporal dynamics of disease transmission. Through a study of two bacterial diarrheal diseases in rural Bangladesh, Emch et al. (Chapter 14)

explore how disease transmission may be mediated by kinship-based social networks and lead to variations in disease incidence beyond the effects of the local neighborhood context. The chapter concludes that simultaneous social network and spatial analysis can help us better understand disease transmission. Based on simulation of individuals' vulnerability to influenza in an urban area in the Northeastern U.S., Bian et al. (Chapter 15) highlight the role of individuals in disease transmission and explore a model design for representing mobile, heterogeneous, and interacting individuals and their vulnerability to infectious diseases. With a focus on the effects of routine human movement on dengue transmission, Wen, Lin, and Fang (Chapter 16) examine the role of commuters in the transmission of the virus from their homes to workplaces in Tainan City, Taiwan. The chapter concludes that commuting was a significant risk factor contributing to the geographic diffusion of the epidemic and certain local neighborhood characteristics are independent facilitating factors.

Exploring spatiotemporal patterns of disease incidents can help researchers identify high-risk areas and specific disease risk factors. Through a Kenya case study, Messina et al. (Chapter 17) present a modeling framework for combining a temporally and spatially dynamic species distribution model with a dynamically downscaled regional climate model to predict tsetse populations over space and time. Using residential histories data, Wheeler, Ward, and Waller (Chapter 18) explore spatiotemporal clusters of non-Hodgkin lymphoma in four metropolitan regions in the U.S. The study found that genetic factors and exposure to polychlorinated biphenyls (PCBs) did not fully explain previously detected spatiotemporal clusters of the disease. Based on data from a sample of predominately injection drug users in Baltimore City, Tobin et al. (Chapter 19) investigate the spatial pattern of individuals who report sex exchange and who do not exchange. The results indicate spatial clustering of sex exchangers and in particular identify the high density of sex exchangers in one specific housing complex. The last chapter in this section by Beyer, Tiwari, and Rushton (Chapter 20) describes five important properties of disease maps that will lead to maps that are best for supporting public health uses. It presents an approach to implement these properties and demonstrates it with small-area data from a population-based cancer registry.

Seven chapters examine *health care provision, access, and utilization* from different theoretical and methodological perspectives. Drawing upon interview data from a study of long-term home care in Ontario, England and Dyck (Chapter 21) explore the lived experience of care work by migrant workers through the themes of routes, responsibilities, and respect that emphasize the embodied care work relation. The chapter shows that the experience of care workers can be understood in terms of the complex interplay among labor market inequalities, embodiment, and Ontario's regulatory mechanisms of care provision. Based on a study of the siting of residential social service facility ("group home") in central Massachusetts, Pierce et al. (Chapter 22) examine the role of informal development politics in generating landscapes of mental health provision that is highly uneven in socially and economically depressed areas. Results of the study highlight the need to include the social and political processes of siting in geographic analysis of mental health. Mennis, Stahler, and Baron (Chapter 23) examine how accessibility and neighborhood socioeconomic context influenced treatment continuity for a sample of drug-dependent patients at an inner city hospital in Philadelphia. The study found that a high crime rate in the patient's home neighborhood or the hospital neighborhood and longer travel time to treatment suppress treatment continuity.

Wang (Chapter 24) provides a helpful review of recent methodological advances in the measurement, optimization, and impact of health care accessibility. The chapter suggests that the development of simplified and transparent proxy measures of health care accessibility will be particularly relevant to public health professionals, in light of the increasing complexity of accessibility models. The two chapters that follow focus on nationwide analysis of the utilization and demand for cancer screening services in the U.S. Using Medicare data on insured persons aged sixty-five or older, Mobley et al. (Chapter 25) examine breast cancer and colorectal cancer screening behavior in each state of the U.S. The study observed distinctive geographic patterns and racial differences in the utilization of cancer screening services (e.g., Hispanics in six states are significantly more likely to utilize mammography than whites). Shi et al. (Chapter 26) assess demand for cancer screening facilities using a two-step floating catchment area method that takes into account both travel time and facility capacity. The results show distinctive geographic patterns of demand for cancer screening facilities: spatially continuous but relatively low in eastern regions but sporadic and tends to be high in the west. Using patient registration data, Lewis and Longley (Chapter 27) examine access to primary health care in the London borough of Southwark. The study observed that different ethnic groups have different behavioral patterns in accessing general practitioner-run health centers.



Four chapters explore pertinent issue of *health and well-being* in various contexts through feminist, therapeutic landscape, and nature-society perspectives. They emphasize the importance of local-level social and cultural dynamics that shape health behaviors and outcomes. Based on two case studies, Thien and Del Casino (Chapter 28) demonstrate how various sociospatial practices of masculinity affect men's health and their affective relationships with support systems for health. The article concludes that "men's health is not only about the management of their responsibilities as political citizens but as biological citizens with all the attendant emotional geographies." Pope's chapter (Chapter 29) addresses the recent history of HIV and HIV policy in Cuba and Belize through a therapeutic imaginaries framework. Through these two case studies, it shows that countries in the same region can develop different care policies that lead to different biomedical and sociocultural outcomes. The chapter demonstrates how gender dynamics, geopolitics, economic philosophies, and cultural norms intertwine to create different disease outcomes even for countries in the same region.

Drawing upon insights from feminist geographies of well-being and nature-society geographies of health, Sultana (Chapter 30) examines chronic arsenic poisoning and water contamination in rural Bangladesh in order to highlight the role of the complex interactions among economic, political, geological, and social systems in shaping health and well-being in the context of development. The chapter emphasizes that the experiences of health and well-being are often highly complex, and public health crises like slow poisoning can be an outcome of development endeavors and environmental factors at the same time. In the context of governmental promotion of traditional medicine in managing human health, King (Chapter 31) investigates local-level dynamics that influence perceptions of health, health decision-making, and the use of traditional medicine within rural areas in South Africa. The chapter concludes that future research on health and well-being needs to attend to the social and cultural processes that shape health perceptions and decision-making in important ways.

The last section addresses *global/transnational health and health issues in the Global South*. To advance our critical understanding of global health, Brown, Craddock, and Ingram (Chapter 32) propose a "critical geographical approach that entails reflexivity about the processes by which problems are constituted and addressed as issues of global health." The chapter discusses three analytical approaches that offer complementary insights into these processes: governmentality, risk, and assemblage. It emphasizes that "global health problems and responses are not given but are enabled, imagined, and performed via particular knowledges, rationalities, technologies, affects, and practices across a variety of sites, spaces, and relations." Based on in-depth interviews with key informants from urban health posts, Wadhwa (Chapter 34) examines AIDS awareness and attitudes in the community and HIV/AIDS policy efficacy in four slums in two cities in India. The study revealed a largely reactive governmental response and significant socioeconomic and institutional barriers to timely conceptualization and implementation of HIV/AIDS policies. The chapter shows how the structural violence and grief model frameworks can be fruitfully employed to shed light on the slow policy progression in India.

Using GIS, spatial statistics, interactive mapping, and data about where participants lived, worked, bought drugs, and injected drugs, Brouwer et al. (Chapter 33) investigate the spatial epidemiology of HIV among injection drug users in Tijuana, Mexico. The study identified a 16-km<sup>2</sup> hotspot near the Mexico-U.S. border with distinctive social and structural environmental characteristics (e.g., lower homeownership and higher divorce and female-headed household rates). It found that HIV-positive participants most strongly clustered by injection locations when compared to residence or work place. The chapter concludes that targeting only a small area in Tijuana would have considerable effect on HIV incidence because of the observed high geographic concentration of HIV. Using a representative survey from the Mexican 2000 Census and multilevel models, Riosmena et al. (Chapter 35) examine how migrant flows may transform the health and nutritional profile of people in former communities. The study found that, largely through the mediating effects of remittance intensity, community-level migration intensity had a significant and positive effect on individual risk of being overweight and obese.

Together these thirty-four chapters cogently show how geographic perspectives and methods can contribute in significant ways to advancing our understanding of the complex interactions between social, political, economic, cultural, institutional, and physical environments on the one hand and health behaviors and outcomes on the other. They indicate that geographies of health, disease, and well-being are far too complex to be fully deciphered by any single perspective or any one group of explanatory factors (e.g., individual attributes, environmental features, social relations, institutional processes, and cultural norms). Different theoretical and methodological perspectives can often enrich each other and enhance our

understanding better than using just one approach. It would thus be helpful to move beyond the binary thinking that treats analytical medical geography and social/cultural health geography as two separate (and even antagonistic) domains (Kwan 2004). Further, as discussed in the chapters by Lam (Chapter 7) and Kwan (Chapter 9), it is important to note that research findings of health studies can be much less certain or reliable than they appear due to uncertainties and errors arising from various sources. To improve the validity or reliability of research findings, much research on the many sources of spatial and temporal uncertainties and means for mitigating their effects on research results is still needed.

Place-based analysis of health behaviors and outcomes need to attend to a vast array of processes and contexts that interact in a highly complex manner. As most people move around in their daily life and over the life course, they are under the influence of many different places at different times besides their residence (Gatrell 2011; Kwan 2009). Health geographers thus need to move beyond the traditional focus on static locations or places (e.g., residential neighborhood) and extend conventional conceptualizations of geographic context to take into account the effects of people's movement and mobility on health (Kwan 2012a,b, 2013). In order to do this, health researchers and geographers have recently begun to deploy advanced geospatial technologies and various location-aware devices (e.g., GPS and mobile phones) to collect high-resolution space-time data about people's activities and trips (e.g., Wiehe et al. 2008; Shoval et al. 2011; Almanza et al. 2012; Rodríguez et al. 2012; Richardson et al. 2013). For instance, it is only through collecting and using GPS and mobile phone data that researchers can now track the mobility of human or animal agents (hosts) and be able to study the complex interactions between the movement of these agents and the spread of the disease (e.g., Wesolowski et al. 2012). Further, it is only through the use of an integrated personal real-time air pollution monitoring system, which integrates a GPS with a personal real-time environmental monitoring unit, that assessment of people's exposure to air pollution can achieve an accuracy level not possible before (Fang and Lu 2012). To better identify modifiable risk factors and to inform intervention measures, many health studies also integrate and use a variety of spatial data to analyze the complex causal pathways between contextual variables and health outcome/behavior variables. The possibility to develop and use new methods to operationalize more robust conceptualizations of geographic context along this line is indeed promising.

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# Ethnic Density and Maternal and Infant Health Inequalities: Bangladeshi Immigrant Women in New York City in the 1990s

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How do the social and material characteristics of residential contexts in the host country affect immigrant maternal and infant health? We examine this question through the lens of the ethnic density hypothesis, a hypothesis that posits beneficial effects on immigrant health of living in areas of high ethnic density; that is, among a socially and linguistically similar population. We analyze the association between infant low birth weight and ethnic density for Bangladeshi immigrant mothers in New York City during a period of rapid and sustained immigration (1990–2000). For Bangladeshi immigrant women, ethnic neighborhoods can provide an important source of social and material support during pregnancy. Geographic information systems (GIS) and spatial analysis methods are used to create a fine-grained indicator of ethnic density. Results show that the relationship between ethnic density and infant low birth weight changed over time. The lack of association in the early years (1990 and 1993) might reflect the fact that the Bangladeshi population had not yet reached a sufficient size, or spatially clustered settlement pattern, to provide dense ethnic neighborhoods and concentrations of social and material resources. In 2000, we observe a U-shaped association between low birth weight and density: Women living in ethnically isolated settings and those living in high-density enclaves are more vulnerable to adverse infant health outcomes. The results suggest the need for a more nuanced understanding of immigrant maternal and infant health and ethnic density that incorporates the dynamism of immigrant experiences and their associations with shifting spatially and socially defined residential environments.

东道国居住环境的社会和物质特性怎样影响移民孕产妇和婴儿的健康？我们通过种族密度的假设来研究这个问题，我们假定生活在族群密度高的地区，即生活在社会和语言类似的人群之间，对移民的健康存在有益的影响。我们分析一个快速和持续的移民时期（1990 至 2000 年），在纽约市的孟加拉移民母亲所生婴儿的低出生体重和种族密度之间的关联。对于孟加拉国的移民妇女，民族聚居区是其怀孕期间的社会和物质支持的一个重要来源。使用地理信息系统（GIS）和空间分析方法创建一个种族密度的细粒度指标。结果表明，民族的密度和婴儿低出生体重之间的关系随着时间的推移而改变。相关性在早年（1990 和 1993）的缺乏，可能反映了孟加拉人口尚未达到足够的规模，或空间聚集的聚落形态不足以提供密集的民族聚居区，社会，以及物质资源的强度。我们观察到在 2000 年，低出生体重和密度之间的 U 形关联：生活在种族分离环境和那些生活在高密度飞地里的妇女更容易受不利于婴儿健康的因素影响。结果表明，我们需要更细致入微地了解移民孕产妇和婴儿的健康和种族密度，综合考虑移民经验的动态以及空间转移和社会性居住环境的相关性。关键词：孟加拉国，族群密度，移民，低出生体重，纽约市。

¿Cómo afectan las características sociales y materiales del contexto residencial en el país anfitrión la salud de madre e hijo inmigrantes? Examinamos esta cuestión a través de la lente de la hipótesis de densidad étnica, una hipótesis que propone efectos benéficos para la salud de los inmigrantes que viven en áreas de alta densidad étnica; esto es, que viven entre una población social y lingüísticamente similar. Analizamos la asociación existente entre el bajo peso de los infantes al nacer con la densidad étnica para madres inmigrantes de origen bangladeshí en la Ciudad de Nueva York, durante un período de inmigración rápida y sostenida (1990–2000). Para las mujeres inmigrantes bangladeshí, los vecindarios étnicos pueden representar una fuente importante de apoyo social y material durante la preñez. Se utilizaron métodos de sistemas de información geográfica (SIG) y de análisis

espacial para crear un indicador de la densidad étnica de grano fino. Los resultados muestran que la relación entre la densidad étnica y el bajo peso de los infantes al nacer cambió a través del tiempo. La falta de asociación en los años iniciales (1990 y 1993) podría reflejar el hecho de que la población bangladeshí todavía no había alcanzado un tamaño suficiente, o un patrón de asentamiento espacialmente aglomerado, para proveer vecindarios étnicos densos y concentraciones de recursos sociales y materiales. En el 2000 observamos una asociación en forma de U entre bajo peso al nacer y la densidad: las mujeres que vivían en conjuntos étnicamente aislados y la que residían en enclaves de alta densidad eran más vulnerables a tener que enfrentar situaciones adversas de salud en sus infantes. Los resultados sugieren la necesidad de un entendimiento más matizado de la salud materna e infantil de los inmigrantes, y de la densidad étnica, que incorpore el dinamismo de las experiencias del inmigrante y sus asociaciones con los cambiantes entornos residenciales espacial y socialmente definidos.

**I**mmigrant health is a critically important and relatively neglected concern in the United States. Although the past three decades saw the highest levels of immigration to the United States since the early 1900s (Monger and Yankay 2011), little is known about socioeconomic and environmental influences on immigrant health and how those play out in particular place contexts. Immigrant health has strong transnational dimensions, reflecting migrant experiences in the home and host countries, along with the physical and psychosocial stresses associated with migration and resettlement (Kerner et al. 2001). Researchers theorize that immigrant health in the host country is influenced in part by “ethnic density”—the localized concentration of an immigrant’s own ethnic group in her or his residential neighborhood. Ethnic density, it is argued, provides opportunities for social interaction and access to culturally appropriate resources and services that are beneficial for physical and psychosocial well-being. Ethnic density, however, is a dynamic construct that evolves over time as immigrant settlement patterns change and unfold.

For Bangladeshi immigrants in New York City, we analyze changes in the association between immigrant infant and maternal health and ethnic density during a period of rapid and sustained immigration (1990–2000). During the 1990s, the Bangladeshi population in the city grew by over 400 percent, from 4,955 to 28,269, primarily as a result of immigration (New York City Department of City Planning 2004). Rapid growth led to changes in settlement, including the emergence of relatively dense Bangladeshi neighborhoods. We investigate the links between these geographic changes in immigrant settlement and reproductive health inequalities for Bangladeshi immigrant women. To gauge reproductive health, we use infant low birth weight (LBW; <2,500 g), a widely used indicator of the health and well-being of both infants and mothers. Geographic information systems (GIS) and spatial analysis

methods are used to create a fine-grained indicator of ethnic density. The results suggest the need for a more nuanced understanding of immigrant health and ethnic density that incorporates the dynamism of immigrant experiences and their associations with shifting spatially and socially defined residential place environments.

### **Immigrant Health Inequalities and Ethnic Density**

Wide inequalities in health among population groups are a persistent concern in the United States. Research on health inequalities typically emphasizes class and racial divisions and neglects the impact of immigration. In health statistics, immigrants are often hidden from view, grouped with nonimmigrants into broad ethnic categories. The “healthy immigrant effect”—the fact that many immigrants are healthier than their counterparts in their home country and U.S.-born citizens—also detracts attention from immigrant health concerns. Although research has confirmed the healthy immigrant effect for a range of health conditions and immigrant populations (Singh and Yu 1996; Baker and Hellerstedt 2006), there are also wide health disparities within and among immigrant groups.

Following contemporary relational perspectives in health geography (Cummins et al. 2008), we can conceptualize immigrant health as reflecting experiences and conditions in the country of origin, the host country, and the process of migration. Regarding experiences in the host country, studies have explored the roles of contextual factors that describe an immigrant’s living environment (Lorant, Van Oyen, and Thomas 2008). Place context affects immigrants’ everyday negotiations, environmental exposures, and access to health-related resources—all of which affect health and well-being. It influences access to social and economic resources including employment, education, and social

and health care services (Smaje 1995; Wang 2007; Thomas 2010) and exposure to stressors in the local environment including crime, traffic, and environmental hazards (Elliott et al. 2004; De Jesus et al. 2010). At the same time, place context is closely related to social and cultural resources and networks. Immigrants often have strong place-based social ties based on ethnicity and country of origin (Dyck 1995). Dyck (2006) described the “sedimentation of place” for immigrant women through daily routines and activities that revolve around culturally familiar institutions, shops and services, and strong local social networks. Families and communities provide essential social resources for maintaining health in the host country (Cervantes, Keith, and Wyshak 1999). These social and spatial relations, rooted in place, intersect in complex ways to affect immigrant health.

The *ethnic density hypothesis*, first described in the mental health literature, posits beneficial effects on health of living among a socially and linguistically similar population, especially for immigrant and ethnic minority populations. Health improvements for those living in areas of high ethnic density are attributed to reduced exposure to prejudice and increased social support (Halpern and Nazroo 1999; Becares, Nazroo, and Stafford 2009). Ethnic density could foster high levels of social capital that develop through place-based institutions and social networks that provide resources and support during times of stress (Fullilove 1988; Sampson, Morenoff, and Earls 1999). Studies have found improvements in physical health through increased protection from the consequences of stigmatization and racism (Pickett and Wilkinson 2008), enhanced social cohesion (Kawachi 1999), mutual social support (Berkman and Glass 2000), a greater sense of community and belonging (Smaje 1995), and reduced levels of stress (Wilkinson 2005). Studies of specific health outcomes have shown an inverse relationship between ethnic density and self-reported ill health status (Smaje 1995), diet (Osypuk et al. 2009), life satisfaction (Lackland 1998), and heart disease (Franzini and Spears 2003). The protective mechanisms reported in these studies included a positive ethnic identity, civic participation, help from social networks, and positive coping behaviors.

At the same time, other research presents more mixed evidence about the associations between ethnic density and health. Pickett et al. (2009) utilized data from the Millennium Cohort Study in the United Kingdom on infant outcomes among various ethnic groups. This study found that Pakistani and Bangladeshi

mothers living in neighborhoods with 5 to 30 percent same-ethnic density were significantly less likely to experience limited long-standing illness. Indian and Pakistani mothers were also less likely to report “ever being depressed” if they lived in dense ethnic neighborhoods. Other health outcomes did not vary with ethnic density, however. Analyzing the relationship between premature birth and ethnic density for broad racial and ethnic groups in New York City, Mason et al. (2010) found that high ethnic density was protective for whites but detrimental for blacks—a finding observed in studies of racial segregation and health (Grady 2006). Using county-scale data for the United States, Shaw, Pickett, and Wilkinson (2010) reported reduced odds of infant mortality among Hispanic mothers living in areas of high group density. Similarly, a study focusing on infant LBW for ethnic minority populations in Chicago found that ethnic density was protective for Hispanics and whites (Masi, Hawkey, Piotrowski, and Pickett 2007), but the study did not assess the effects of immigration. In general, findings are difficult to compare because of the diversity of health indicators, geographic settings, immigrant race and ethnic populations, and definitions of ethnic density used in testing for density effects.

Although elegant in its simplicity, the ethnic density hypothesis raises several important questions. It is ambiguous about the geographical scale at which density effects might be observed. There might be complex threshold effects—critical density levels needed to sustain social interactions in a particular place. Two recent studies indicate a nonlinear association between density and health (Neeleman, Wilson-Jones, and Wesseley 2001; Fagg et al. 2006). Furthermore, a large literature suggests that living in ethnically or racially segregated communities could be detrimental to health (Williams and Collins 2001; Subramanian, Acevedo-Garcia, and Osypuk 2005; White and Borrell 2011). For immigrants, this can occur if immigrants cluster in economically and environmentally disadvantaged communities or if segregation is associated with feelings of stress, subordination, and disempowerment caused by racial or ethnic discrimination (Osypuk and Acevedo-Garcia 2010). Living in ethnic enclave areas also inhibits social interactions with other groups, limiting development of “bridging” social capital; that is, social capital derived from interactions among dissimilar persons (Kim, Subramanian, and Kawachi 2006). Given the complexity of processes linking ethnic density and health, the association (if any) is likely to change over time as immigrant settlement patterns

evolve and as social interactions within and among immigrant and nonimmigrant populations develop and change.

We explore the ethnic density hypothesis for Bangladeshi immigrant women and their infants during the 1990s, a period of very rapid Bangladeshi immigration to New York City. The 1986 Immigration Reform and Control Act, coupled with the diversity visa program aimed at encouraging immigration from underrepresented countries, fueled Bangladeshi immigration to the United States, making Bangladesh one of the top twenty source countries of immigrants in the 1990s (New York City Department of City Planning 2004). Many of these immigrants sought employment in low-income sectors of the economy (e.g., waiters, bartenders, vendors, taxi drivers). This wave of immigration also gave rise to several dense Bangladeshi neighborhoods with visible social, cultural, and economic spaces. A high poverty rate, large household sizes, and unstable employment made Bangladeshis vulnerable to adverse socioeconomic circumstances. Bangladeshi immigrants to New York City during the early 1990s were also very young (with a median age of twenty-three years) and predominately male, with a ratio of 143 males per 100 females (New York City Department of City Planning 1996).

Bangladeshi women immigrants in New York City came primarily as spouses with limited English proficiency and were relatively young and with low income. They had significant needs for health care services, especially reproductive health care. Qualitative research shows that the everyday lives of Bangladeshi women residing in the city are quite proscribed spatially and culturally (Chakrabarti 2010). Being primarily housewives, women shoulder the major burden of household and child care responsibilities and are tied to neighborhood spaces. Some work in part-time, low-paying jobs near home to supplement family income. Women's embeddedness in neighborhood spaces and their interactions with other Bangladeshi women and families characterize their daily sociospatial settings (Chakrabarti 2010), as they do in countries like the United Kingdom (Phillipson, Ahmed, and Latimer 2003). Moreover, Bangladeshi immigrant women in New York City are not homogeneous. Recent low-income immigrants whose everyday socio-spatial spaces are constrained by strict gender roles and a limited knowledge of English are particularly vulnerable (Chakrabarti 2010). These qualitative studies suggest that spaces of high ethnic density present a mix of opportunities and challenges for Bangladeshi immigrant women,

with potentially complex implications for health disparities.

## Data and Methods

Data for this project come from vital statistics birth records for New York City for 1990, 1993, 1996, and 2000. For each birth, the data report characteristics of the mother such as age, birthplace, and education, along with characteristics of the infant such as birth weight, parity, and gender. Representing a near-complete registry of births among New York City residents, these vital statistics data have been widely used in analyzing maternal and infant health outcomes (Grady 2006; Mason et al. 2010). Despite limitations such as missing values, the data are a rich source of information about changes in health inequalities through space and time. We identified Bangladeshi immigrant mothers by country of birth, and the mothers' locations were geocoded to the residential census tract at the time of birth. Multiple births (i.e., twins, triplets) were excluded because these infants are highly likely to be small (low weight) at birth. The numbers of births ranged from 318 in 1990 to 1,373 in 2000.

The health outcome of interest is LBW, a dichotomous variable indicating whether an infant weighed less than 2,500 g at birth. LBW is a widely used measure of maternal, infant, and community health. It is the most important risk factor for infant mortality and has been linked to a host of physical and developmental problems in infancy and childhood. It is also a key indicator of maternal health, reflecting stress, nutrition, risk behaviors, and access to health care during pregnancy. Independent variables describe maternal characteristics including marital status, age, education, and insurance coverage. Maternal characteristics were defined as dichotomous variables including marital status (MARRIED; 1 = married), high school education (HIGHSCH, 1 = completed twelve years of education), and enrollment in the Medicaid health insurance program (MEDICAID).

In estimating ethnic density, we use the birth data rather than data on total Bangladeshi population. Census counts of total Bangladeshi population were not available for either of the intercensal years (1993, 1996) or for 1990, so we used data on mothers' residential locations to approximate the spatial distribution of Bangladeshi population. In this sense, our measure describes a mother's geographical proximity to other Bangladeshi mothers during the year of birth.

Kernel density estimation (KDE), calculated within a circular window using a quartic kernel function, was used to characterize the uneven density of mothers (per square mile) across the city. Several recent studies employ KDE in computing measures of residential segregation and ethnic concentration (O'Sullivan and Wong 2007; Mason et al. 2010). The resulting KDE output was then used to assign each mother a density value corresponding to her residential location. A critical parameter when computing a KDE is the search bandwidth (radius). We used two different bandwidths: 1.0 and 1.5 miles. The 1.5-mile bandwidth produced a smoother, less spiky map than the 1.0-mile bandwidth and appeared to better represent local neighborhood-scale variation in ethnic density. We only discuss the 1.5-mile results here, although findings were very consistent for both bandwidth values.

This ethnic density measure differs from those used in previous studies in that it focuses only on mothers and not the entire immigrant population. It reflects our assumption that other mothers who give birth in the same year provide an important source of social support during pregnancy, which is supported by qualitative research on Bangladeshi mothers' access to prenatal care (Chakrabarti 2010). Our measure is limited, however, insofar as it omits a large fraction of the Bangladeshi population that also offers social and material support. To check the correspondence between our density measure and one based on total population, we obtained data from the 2000 Census on Bangladeshi population by census tract and computed ethnic density via the same kernel estimation procedures. The two density measures were very highly correlated ( $r = 0.988$ ), indicating that our measure does well in capturing geographic variation in total Bangladeshi population.

Also important is the fact that our ethnic density measure emphasizes absolute density rather than a group's share of the local population. Given the small size of the Bangladeshi population, even in the neigh-

borhoods of highest density, this community represents only a tiny fraction of the total population. Focusing on absolute density highlights the presence of mothers from the same ethnic background in a woman's residential neighborhood, representing the potential for ethnic group-based social interactions and networks, irrespective of the group's share of local population. In contrast, relative density measures, used in many studies of the ethnic density hypothesis (Becares, Nazroo, and Stafford 2009; Mason et al. 2010), describe a group's segregation in an area to the exclusion of other population groups.

To assess whether this absolute measure of ethnic density might be confounded by overall population density, we included population density as an additional independent variable. Decennial census data were used for computing population density values in 1990 and 2000; for 1993 and 1996, values were estimated via linear interpolation. For 2000, the year with the largest sample size, additional analyses were performed to determine the influence of the following contextual variables that describe social and spatial characteristics of the residential census tract: percentage of households with incomes below poverty, median household income, network distance to the closest publicly funded prenatal care center, and the prevailing smoothed tract LBW percentage, excluding births to Bangladeshi mothers. These contextual factors might underpin any observed associations between ethnic density and LBW risk.

## Results

Reflecting the rapid growth of Bangladeshi population in New York City, the total number of Bangladeshi mothers in our sample increased by more than 400 percent from 1990 to 2000 (Table 1). Data from the birth certificates present a shifting portrait of Bangladeshi infants and mothers throughout the decade. The percentage of LBW incidents ranges from 7.9 in 1990 to

**Table 1.** Social and characteristics of Bangladeshi immigrant mothers and births

Year	Number of births	Characteristics of mothers and infants					
		% LBW ( <i>n</i> )	% $\geq 12$ years education	% $\geq 16$ years education	% married	% Medicaid	% self pay
1990	318	7.9 (25)	59.8	21.7	78.6	53.8	13.8
1993	592	11.0 (65)	72.1	19.6	68.8	61.0	21.6
1996	726	8.8 (64)	77.2	24.2	55.0	75.5	8.0
2000	1,373	8.5 (117)	72.9	22.9	78.5	79.1	3.1

Note: LBW = low birth weight.



11.0 in 1993. In all years except 1990, the LBW percentage for Bangladeshi mothers exceeded the city-wide value by more than 1.5 percentage points. Bangladeshi women's greater risk of delivering an LBW infant has been observed in other studies (Kelly et al. 2008; Stein et al. 2009), and it is consistent with the high risk seen among women in Bangladesh. Because the vast majority of women in our data set are likely to be recent immigrants, their elevated risk of infant LBW might in part reflect risks associated with the home country; still, the consistently elevated values show that LBW is an important health issue for this vulnerable population.

The mothers' educational characteristics remained relatively stable during the 1990s: Approximately three fourths of mothers reported having a high school education and 20 percent had a college education. The percentage of mothers with Medicaid insurance coverage rose from 53.8 percent in 1990 to 79.1 percent in 2000, reflecting the expansion of Medicaid eligibility in the 1990s (Zavodny and Bitler 2010). At the same time, the proportion of uninsured, "self-pay" mothers declined to just 3 percent in 2000. This indicates Bangladeshi mothers' expanded access to government-funded medical insurance coverage during the study period.

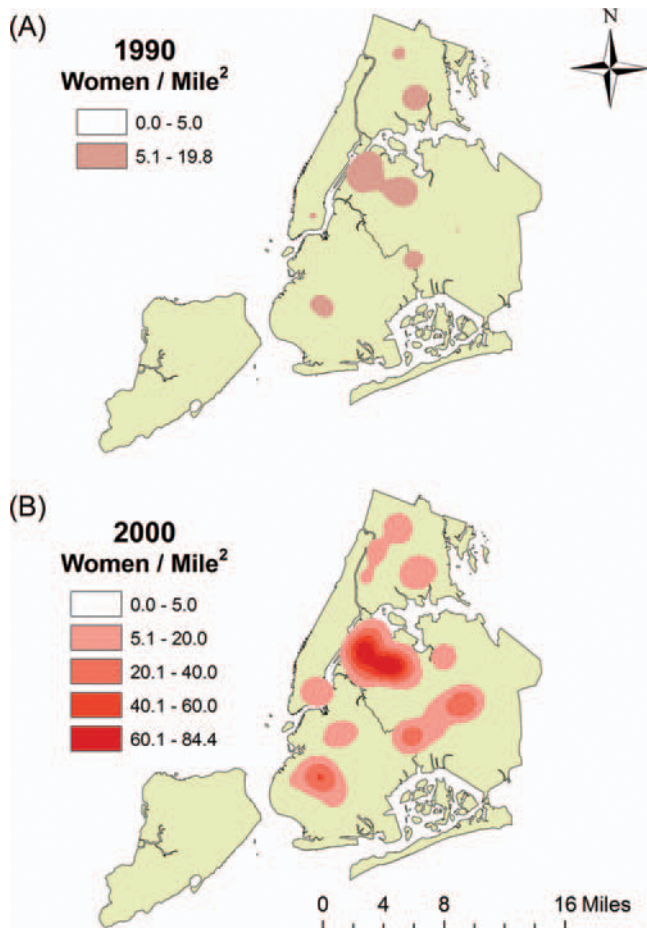
The data on marital status present a more complex picture. The percentage of Bangladeshi mothers listed as married fluctuated greatly from year to year, ranging from 55.0 percent in 1996 to 78.6 percent in 1990. Both the low percentages and fluctuation over time raise concerns about the accuracy of reporting nonmarital status. Unlike most states, New York State does not permit the asking of a direct question to determine marital status for the birth certificate. Instead, marital status is inferred. Births are considered nonmarital if a paternity acknowledgement was filed or the father's name was missing from the birth certificate (New York City Department of Health and Mental Hygiene 2010). It is possible that due to language and cultural barriers, some Bangladeshi immigrant mothers might not have written the father's name on the birth certificate, even if married. During the early and mid-1990s, few hospitals had Bengali language translation services, placing immigrants who did not speak English in a vulnerable position. Thus, the unmarried group could include some married women who did not provide the necessary information to be recorded as "married." In 2008, only 11.3 percent of Bangladeshi mothers were identified as unmarried—a value that is probably closer to the true value for the years we studied (New York City Department of Health and Mental Hygiene 2008).

**Table 2.** Spatial characteristics of Bangladeshi immigrant births

Year	Geographic characteristics			
	No. tracts with Bangladeshi birth	Average density of Bangladeshi births	Moran's <i>I</i>	% mothers in enclave
1990	188	7.4	0.301	36.5
1993	272	14.7	0.318	40.4
1996	303	18.1	0.323	41.8
2000	416	42.4	0.537	44.7

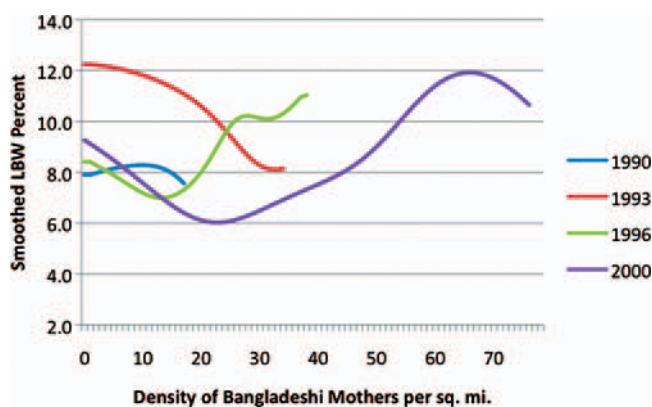
During the 1990s, rapid immigration fueled changes in the spatial distribution of Bangladeshi mothers. The number of census tracts reporting a birth to a Bangladeshi mother rose from 188 to 416 (out of approximately 2,216 tracts) between 1990 and 2000, and the average ethnic density score among mothers also increased (Table 2). In addition, Bangladeshi births became more spatially clustered: The Moran's *I* value for births by tract increased from 0.301 to 0.537. Maps of the ethnic density measure for 1990 and 2000 (Figure 1) show the highly uneven geographic distribution of Bangladeshi mothers and the formation of a large enclave area in northern Queens, in the Astoria and Jackson Heights neighborhoods. The 1990s saw marked increases in density in this enclave area (south-central Astoria and western Jackson Heights), as the percentage of mothers residing in the enclave rose from 36.5 to 44.7 (Table 2). By 2000, several smaller, secondary enclaves had emerged in central Brooklyn and southern Queens. The end result is a strongly nucleated settlement pattern, a pattern typical of Bangladeshi populations in other cities in North America (Ghosh 2007).

To illustrate the association, if any, between ethnic density and LBW, we plotted smoothed LBW as a function of ethnic density for each year, using a local polynomial smoothing algorithm in STATA (Figure 2). The bandwidth ranged from five in 1990 to ten in 2000, to take into account the increasing range of density values. Note that the range of density values is quite small in 1990 and much larger in 2000, reflecting overall population growth. For 1990, no trend is evident between LBW and ethnic density. This makes sense because the small Bangladeshi population size meant that there were no dense concentrations of settlement. The 1993 plot shows an inverse gradient in LBW with increasing density, an indication that LBW outcomes were somewhat better for women living in higher



**Figure 1.** Density of Bangladeshi mothers in New York City, 1990 and 2000. (Color figure available online.)

density neighborhoods. The observed trend might not be statistically significant, however, given the relatively small number of births in that year. The 1996 plot shows a slight U-shaped trend with the highest LBW percentage in high-density areas. A more striking U-shaped



**Figure 2.** Smoothed low birth weight (LBW) percentage by ethnic density, 1990, 1993, 1996, and 2000. (Color figure available online.)

pattern emerges in 2000, with the lowest rate of infant LBW among women living in neighborhoods with moderate levels of ethnic density (10–40 per square mile): Mothers living in both isolated settings and areas of high Bangladeshi population concentration have a higher risk of infant LBW.

To determine whether the trends observed in these graphs are statistically significant after controlling for maternal risk factors, we estimated a series of logistic regression models for each year. Variables representing the mother's age and health insurance coverage were found to be insignificant in all models and had minimal effect on parameter estimates for ethnic density; therefore, they are excluded from the results presented here. We represented ethnic density by using linear and quadratic terms and by defining binary variables representing high and low density. For each year, low density was defined as fewer than ten mothers per square mile; the cutoff value for high density was thirty in 1993 and 1996 and forty in 2000. High density was omitted for 1990 due to the lack of high-density Bangladeshi areas at that time. For ease of interpretation, we only present the models incorporating the low- and high-ethnic-density designations.

For each of the first three years, the models indicate no statistically significant association between ethnic density and LBW (Table 3), suggesting that ethnic density has little to no relationship with LBW during the first three years. This might be due to small sample sizes that result in insufficient statistical power. It also could be related to a threshold effect. In the early years of immigration, geographic concentrations of Bangladeshis had not reached a sufficient population density threshold for health effects to develop and emerge. In fact, the magnitude of the parameter estimate for the high-density variable becomes large in 1996, pointing to an emerging association between high ethnic density and LBW as Bangladeshi settlement expanded. Associations between other independent variables and LBW also were generally weak during the first three time periods. The consistent inverse association with population density suggests that, independent of ethnic density, living in densely populated urban neighborhoods might be beneficial for Bangladeshi mothers and infants in New York City.

In contrast, the 2000 model shows significant associations between density and LBW (Table 3). The results confirm the U-shaped pattern apparent in Figure 2 in which risk is elevated among infants born to mothers living in low-ethnic-density neighborhoods, as well as among those living in high-density neighborhoods.

**Table 3.** Logistic regression coefficients for models of low birth weight risk by year

	Year			
	1990	1993	1996	2000
High school	-0.779 (.486)	-0.537* (.303)	0.367 (.370)	-0.060 (.224)
Married	-0.357 (.477)	0.166 (.302)	-0.352 (.266)	-0.334 (.232)
Density <10	0.106 (.525)	0.135 (.311)	0.054 (.328)	0.597** (.270)
High density		0.035 (.435)	0.495 (.339)	0.690** (.251)
Population density (ln)	-0.937 (.512)	-0.501 (.371)	-0.832** (.349)	-0.304 (.262)
	4.085	6.915	9.832*	12.82**
Model chi-square	$p = 0.394$	$p = 0.227$	$p = 0.080$	$p = 0.028$

Note: Standard errors in parentheses.

\*Statistically significant,  $p < 0.10$ .

\*\*Statistically significant,  $p < 0.05$ .

Living in areas of moderate density confers protective effects with respect to LBW risk. Compared to women living in areas of moderate Bangladeshi ethnic density, similar women in low-density areas have an 82 percent higher risk of delivering a low-weight infant, and those in high-density areas have almost double the odds (Table 4).

To check whether these ethnic density associations are an outcome of well-established contextual factors such as poverty and income levels in the local population, we estimated a series of multilevel models that incorporated the four contextual variables mentioned earlier: poverty, income, distance to prenatal care, and prevailing LBW percentage. The variables were included as level-2 fixed effects. None of these variables, either singly or in combination, yielded a statistically significant improvement in model fit or had a statistically significant coefficient. Moreover, including the variables resulted in little change (<10 percent) in the estimates of the LBW–ethnic density relationship. This indicates that economic disadvantage and other measured characteristics of the contexts in which Bangladeshi women live do not account for the observed association between ethnic density and health.

**Table 4.** Low birth weight (LBW) by ethnic density category in 2000: LBW percentages and odds, adjusted for marital status, population density, and education

Ethnic density	LBW %	Number of births	Adjusted odds of LBW (95% confidence interval)
<10	10.78	269	1.82 (1.22, 3.26)
10–40	6.85	567	1.00
>40	10.24	537	1.99 (1.00, 3.08)

In 2000, the U-shaped association between density and LBW suggests that Bangladeshi immigrant women living in isolated settings and those in the highest ethnic density areas are vulnerable to poor infant health outcomes. In short, some ethnic density is beneficial, but high ethnic density is not. An analysis of psychosocial health among South Asian adolescents in East London reported a similar U-shaped association (Fagg et al. 2006), as have a handful of other studies (Neeleman, Wilson-Jones, and Wessely 2001). These findings might be linked in part to the relative opportunities for bridging and bonding social capital for Bangladeshi immigrant women living in neighborhoods with varying levels of ethnic density. With few Bangladeshi neighbors, women in low-density settings might experience a lack of opportunities for bonding social capital—an outcome of social and spatial isolation from one’s own ethnic group. In contrast, those living in areas of high Bangladeshi density might experience low levels of bridging social capital, leading to a different form of isolation. Although in the high-density areas studied here Bangladeshi people are not geographically isolated from other ethnic groups, strong within-group (bonding) ties among Bangladeshis could decrease the need and opportunities for intergroup (bridging) social interaction. Theoretically, opportunities for both bridging and bonding social capital are maximized for women living in medium-density settings. Protective effects on health have been observed for both types of social capital (Kim, Subramanian, and Kawachi 2006). To the extent that these types of social capital are rooted in residential neighborhoods, living in moderate-density neighborhoods might be beneficial. Chakrabarti (2010) found that place-based social interactions with Bangladeshi mothers provided an important source of social and emotional support for

Bangladeshi women during pregnancy; however, bridging social capital was not evaluated. Direct measurement of social capital across a range of neighborhood contexts is needed to assess the validity of these hypothesized links among ethnic density, bridging and bonding social capital, and maternal and infant health.

Our results indicate that living in areas of high ethnic concentration is associated with poor LBW outcomes—a finding that contradicts the ethnic density hypothesis. Data on birth outcomes for Bangladeshi mothers in London showed a similar elevated risk of LBW in high-concentration areas; however, the risk was not statistically significant (Pickett et al. 2009). In addition to the limited development of bridging social capital, other contextual factors might influence the ties between living in areas of high ethnic concentration and adverse infant health outcomes. Our findings show no influence of absolute economic deprivation at the census tract level, but relative deprivation could come into play, especially given the very high rates of poverty and low income among New York City's Bangladeshi immigrants. Living conditions also warrant attention. There is evidence of necessity-based overcrowding among Bangladeshis, as extended families share small living spaces, and even take on renters, to economize on rental payments (Asian American Federation 2005). Living with extended family members in crowded housing units could result in psychosocial stress, which heightens the risk of infant LBW (Chakrabarti 2010). These crowded conditions might be more prevalent in high-density enclave areas, given the areas' sociocultural attractions for Bangladeshi settlement. Additionally, selective migration might be relevant in understanding the elevated risk of infant LBW for mothers living in high-density areas (Oakes 2004). Over time, such areas might attract recent immigrants or other vulnerable Bangladeshi subpopulations. For example, the birth data show an increasing share of unmarried mothers living in high-density areas. Lacking data on length of residence and other sociodemographic characteristics of the Bangladeshi population, we are unable to assess the role of selective migration; however, it is an important topic for future investigation.

This study points to the adverse health effects for Bangladeshi mothers of ethnic isolation. Such a finding is consistent with the ethnic density hypothesis, but it emphasizes isolation as the primary factor influencing immigrant health, rather than high density. The health vulnerability of immigrant women living in isolated settings has important policy implications. Interventions

to promote immigrant women's health, such as culturally appropriate clinics and health care providers, are often spatially targeted to immigrant enclave areas to maximize geographical access. Given how geographic barriers intersect with cultural barriers in shaping immigrants' access to health care (Wang 2007), however, such policies disadvantage immigrants living in ethnically isolated settings.

## Conclusions

Understanding how the social characteristics of residential spaces in the host country affect immigrant health is an important and relatively neglected topic in health geography. This research suggests that both the health impacts and our ability to detect them are deeply bound up with the changing geographies of immigrant settlement. Although limited to a single health outcome, in a single immigrant population, our findings highlight an important temporal dimension in the development of an association between ethnic density and health. For Bangladeshi mothers in New York City during a period of rapid immigration, an association only became apparent after the Bangladeshi population had reached a sufficient size and a geographically concentrated settlement pattern had emerged. This makes sense: After all, ethnic density can only influence health if the group population size is large enough for density to exist and the settlement pattern is geographically uneven, including some dense concentrations. Links between settlement and ethnic density have been mentioned in recent empirical studies, but none have addressed the temporal dimension (Pickett et al. 2009). We acknowledge that our findings for the earlier years might simply reflect a lack of statistical power due to small numbers of births; however, this is also directly tied to immigrant settlement.

Results for 2000 show a nonlinear, U-shaped association between ethnic density and LBW: Women living in ethnically isolated settings and those living in high-density enclaves are more vulnerable to adverse LBW outcomes. Such outcomes are driven by a combination of effects in which both residential settings are linked to increased vulnerability. These findings support recent studies that show complex and heterogeneous associations between density and health (Subramanian, Acevedo-Garcia, and Osypuk 2005; Osypuk et al. 2009; Mason et al. 2010). Research on ethnic density needs to consider and explicitly model such nonlinear effects. Analyzing whether the U-shaped

association persists in the future, or whether continued Bangladeshi immigration and changing settlement patterns alter its form and significance, is an important topic for future investigation. Moreover, research on other immigrant populations, with varying settlement histories and in diverse geographic contexts, would show whether the U-shaped association applies more broadly.

This research also highlights the benefits of linking GIS, spatial analysis methods, and vital statistics data in studying immigrant health in the United States. The dynamism of immigrant populations and their rapidly changing settlement patterns mean that decennial census data are often out of date, and ethnic group data from the American Community Survey are not released for small levels of geography. Our findings suggest that vital statistics information could be used to approximate the residential changing geographies of ethnic populations. Although quantitative assessments of contextual effects on immigrant maternal and infant health provide an important starting point, the many unanswered questions that arise from our research point to the pressing need for qualitative investigations. Bangladeshi immigrant women's experiences of space, access to social and economic resources, and place-based interactions are critically important in shaping their health vulnerabilities in different geographic settings.

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# With Reserves: Colonial Geographies and First Nations Health

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Health disparities between Indigenous and non-Indigenous peoples persist globally. Northern interior British Columbia, where many Indigenous people live on Indian<sup>1</sup> reserves allocated in the late nineteenth century, is no exception. This article reviews findings from fifty-eight interviews with members of thirteen First Nations communities in Carrier, Sekani, Wet'suwet'en, and Babine territories. The results suggest that colonial geographies, both physical and social, along with extant anti-Indigenous racism, are significant determinants of the health and well-being (or lack thereof) of many First Nations in the region.

土著和非土著人民之间的健康差距在全球范围持续。在不列颠哥伦比亚省内北部，生活在十九世纪末期所分配的印第安保留地里的许多土著人民也不例外。本文评估了包含 Carrier, Sekani, Wet'suwet'en, 和 Babine 领土里的第一民族社区的 13 个成员的五十八个访谈的结果。结果表明，殖民地自然和社会地理，与现存的反土著种族主义，是在该地区的许多第一民族的健康和福祉（或缺乏）的重要决定因素。关键词：不列颠哥伦比亚殖民主义，第一民族的健康，社会和地理因素。

La desigualdades por salud entre pueblos indígenas y no indígenas persisten a escala global. El interior septentrional de la Columbia Británica, donde numerosos pueblos indígenas viven en reservaciones indias establecidas a finales del siglo XIX, no es la excepción a este respecto. Este artículo revisa los hallazgos logrados en cincuenta y ocho entrevistas hechas a miembros de trece comunidades de las Primeras Naciones, en los territorios de Carrier, Sekani, Wet'suwet'en y Babine. Los resultados sugieren que las geografías coloniales, tanto físicas como sociales, junto con el racismo anti-indigenista existente, son determinantes significativos de la salud y bienestar (o falta de los mismos) de varias de las Primeras Naciones de la región.

Lee Edmond<sup>2</sup> is a twenty-six-year-old Dakelh (Carrier) First Nation man born and raised in Cheslatta (Grassy Plains). Cheslatta, on the south side of François Lake in northern interior British Columbia, Canada, has fewer than 350 people. Edmond describes himself as “constantly working as much as [he] can. Just kind of living life, pretty much.” Mention of health services spurs wide-ranging discussions: “My left eye is a prosthetic. I was shot with a 22 when I was eleven months old. The bullet went right in and came out just above my left ear.”

According to 2010 population data, Edmond is one of seventy-six registered Cheslatta-Carrier First Nations men residing in his “home” community, Indian Reserve 620. In 1951, when the Nechako River Valley was flooded to accommodate a hydroelectric dam, Cheslatta people were relocated there from previous reserve lands allocated between 1881 and 1897 without treaty or First Nations agreement. Canada's Department of Indian and Northern Affairs characterizes present-day Cheslatta as

a Zone 2 Indian reserve: It is between 50 and 350 km from the nearest service center with year-round road access. Hunting, fishing, and trapping remain crucial aspects of life (Fiske and Patrick 2000) and unique health challenges (e.g., gunshot wounds) persist, including some of the province's highest rates of mortality from unintentional injuries (British Columbia Provincial Health Officer 2009).<sup>3</sup> Edmond cannot access any medical services for his prosthetic eye in Cheslatta or any nearby community:

Every six months or so I have to catch a bus. It takes quite a while. Fourteen hours down to Vancouver and eighteen and a half hours home. I usually just stay for one night. They're cleaning my eye and resizing it and all that. Sometimes they let other people in ahead of me and stuff. I pretty much know why. . . . I'm Native.

This article is about the ill health and health experienced by Edmond and many other First Nations peoples in northern interior British Columbia.



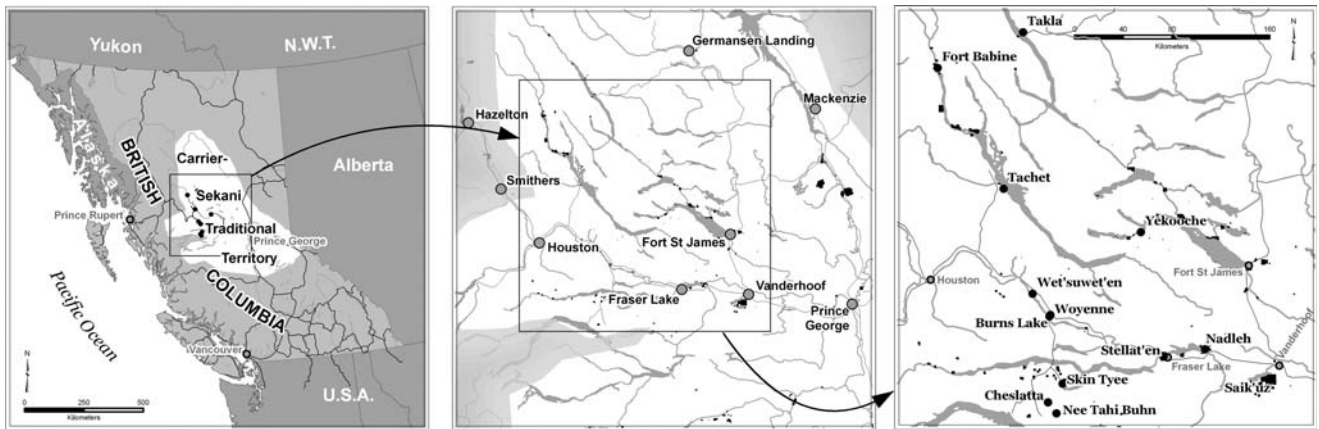


Figure 1. Traditional territories, First Nation communities, present-day Indian reserve spaces and allocations.

Specifically, we argue that First Nations' poor health can only be ameliorated if understood as geographically and historically determined, linked to colonial practices, and associated with dominant systems of social power that spatially and socially (re)produce Indigenous peoples as perpetually othered. Our research is informed by studies about the socially determined nature of Indigenous peoples' health (Kirmayer, Brass, and Tait 2000; Nettleton, Napolitano, and Stephens 2007; de Leeuw, Greenwood, and Cameron 2010) and is meant to dialogue with critical health geography and the emergent subfield of Indigenous geography, both of which value social justice and the politicization of geographic inquiry (Parr 2004; Shaw, Herman, and Dobbs 2006; Buzzelli and Veenstra 2007; Pualani-Louis 2007; Watson and Huntington 2008; Cameron, de Leeuw, and Greenwood 2009; Carmalt and Faubion 2009; Curtis and Riva 2010a, 2010b). Our work privileges partnerships with First Nations and is grounded in qualitative data gathered from fifty-eight participants from thirteen First Nations communities (see Figure 1). Despite its regional context, our conclusions might offer insights into persistent gaps between Indigenous and non-Indigenous peoples' health globally.

## Background

British Columbia is the outcome of long-standing and ongoing colonial work, both discursive and material in nature, undertaken in shifting, complex, and asymmetrical ways (Williams-Braun 1997; Harris 2004; Kobayashi and de Leeuw 2010; Oliver 2010). The results are tense geographies of different social, cultural,

economic, and political powers and unstable boundaries, borders, laws, policies, and sociocultural protocols that, although continually resisted, still persist (Blomley 1996; Harris 1997, 2002, 2004; Sparke 1998; Clayton 2000, 2001–2002; Rossiter and Wood 2005). Colonial ideologies and government legislation that, literally and figuratively, mapped Indigenous peoples out of British Columbia and onto Indian reserves (Brealey 1995; Harris 2002, 2004) have resulted in contemporary tensions about everything from jurisdictional privileges and laws, a lack of treaties, human rights violations, and unequal allocation of resources (Sterritt et al. 1998; Schouls 2003; Stanger-Ross 2008; Irlbacher-Fox 2009). Eighteen residential schools, focused on transforming children and cultures, operated for over 100 years in the province (de Leeuw 2007, 2009). Indigenous peoples were not able to vote federally until 1960. The federal 1876 Indian Act, remarkably unchanged until 1951, produced taxonomies of being or not being Indian that carry into today.<sup>4</sup> The minimal rights and privileges linked to being a Status Indian include some limited access to extended health benefits, educational support, and resource harvesting rights. These socially engineered categories were, and remain, premised on blood-quantum logics and the places where a person lived (Lawrence 2003, 2004; de Leeuw and Greenwood 2011). Today, Status Indians in British Columbia carry status cards to prove identity when accessing, among other things, health services and, like all other Status Indians across Canada, they are governed differently than their non-Indigenous counterparts (Legal Services Society of British Columbia 2007).

In neocolonial landscapes around the world, colonialism is a factor in health divisions between Indigenous and non-Indigenous peoples (Waldram,



Herring, and Young 1995; Adelson 2005; Baum and Harris 2006; Larson et al. 2007; Tarantola 2007; Smylie 2009; de Leeuw, Greenwood, and Cameron 2010). Indigenous peoples in Canada experience higher rates of morbidity, chronic illness, acute trauma from accidents and violence, suicide, addiction, mental health issues, unwanted teenage pregnancy, and exposure to high-risk environments (RHS National Team 2007; Health Canada 2008). Social determinants of health (Commission on the Social Determinants of Health 2007) and intersectionality (Valentine 2007) frameworks, along with critical decolonizing methodologies (Nash 2002; Gilmartin and Berg 2007) indicate that social engineering, legislated disparities in access of services and resources, and forced colonial education have all directly and negatively impacted Indigenous peoples' contemporary well-being (Kelm 1999; Marmot 2005; Kelly et al. 2007; Marmot et al. 2008; Richmond and Ross 2009; Castleden et al. 2010). Much of this research, however, lacks specific or purposeful geographic analysis.

## Research Methods and Methodologies

Undertaking research with First Nations is not a straightforward or apolitical process. Indigenous scholars and community members around the world associate research with colonialism. Research still positions Indigenous peoples as passive subjects from whom information is extracted, to whom results are often not communicated, and for whom the work is often not useful (Smith 1999; Brant-Castellano 2004; Schnarch 2004; Giles and Castleden 2008). Canadian health research is no exception (Smylie 2009). Consequently, in partnership with diverse Aboriginal groups, the Canadian Institutes for Health Research (CIHR) developed comprehensive guidelines for ethical research with Indigenous peoples. Health research must, at minimum, involve researchers who understand and respect Indigenous communities with whom they work, involve co-ownership of the research results to ensure community access to the data, account for participatory-action methods where community can give direction on the project, and must benefit both the community and researcher (see CIHR 2007). In this context, our relationships and methods are worth noting.

Members of this research team have worked together for over a decade, resulting in the development of trust, a well-documented component of successful research in Indigenous communities (Bartlett et al. 2007; Ball and Janyst 2008; Panelli 2008; Ford and Airhihenbuwa

2010). After codeveloping research methods with Carrier Sekani Family Services (CSFS), a “for First Nations, by First Nations” agency guided by First Nations elders that offers comprehensive social, health, and legal programs, the project was vetted through university and First Nations' ethics processes. Two Carrier Sekani youth partnered with an undergraduate medical student as research assistants with CSFS researchers and university academics. During fifty-eight interviews ranging in length from thirty minutes to two hours, which occurred in people's homes or public community spaces, participants answered open-ended questions designed to elicit reflection about their experiences accessing medical and health services, the majority of which are off-reserve. Resulting transcripts were thematically analyzed by CSFS and university partners using the qualitative analysis software HyperRESEARCH coding processes and close reading and narrative analysis practices. Results were validated with community members and participants and all resultant data and research are co-owned.

## Results and Discussion

Three dominant themes about First Nations' experiences of accessing health care services arose on analysis of data. First, First Nations living on reserves in northern interior British Columbia are spatially and materially distant from services. Second, and more important, physical distances underpin a social distancing and a subsequent social construction and racialization of First Nations premised on imagined understandings of reserves as particular kinds of spaces. Finally, we identified what we call “uncommon ground,” or divisions between First Nations worldviews and biomedical models of health care.

From the onset of a project initiated to assess levels of First Nations trust toward mainstream medicine, the role of geography in accessing health care was impossible to ignore. Many participants expressed profound connection with place, linking health and well-being to their land and the activities they undertook on their territories. Conversely, ill health, and not accessing health care services, was often linked to isolation, historically unceded ownership of lands, and social stigmatization because identity was tied to colonial geographies.

### Spatial Distancing

Most participants voiced concerns about being physically far away from services. Distances in remote north

central British Columbia are hazardous: “What happens here,” noted one participant, “is horrendous. [One person in my reserve] travels 2,800 miles a month. This person is quite ill . . . the travel isn’t doing her any good.” Transportation is expensive: “I’ve got two daughters to feed . . . and I might be down a hundred bucks because I spent the day seeing a doctor.” Hitchhiking, the most viable form of transportation to and from health care services for many people, has led in the last fifteen years to approximately eighteen unsolved murders or disappearances of First Nations women and girls along the primary highway<sup>5</sup> through Carrier Sekani Territory. Motor vehicle accidents account for 3.4 deaths per 10,000 in Status Indian populations in northern interior British Columbia, more than triple the number (0.9) in non-Indigenous populations across the rest of the province and a 36 percent greater number than Status Indians across British Columbia (2.5 per 10,000).<sup>6</sup>

Many (more than twenty) participants identified unsafe travel as a deterrent in accessing health services: “It’s too complicated [leaving the reserve]. The things you have to go through, you just don’t feel comfortable at all. So you put your health issues aside until it gets bad,” stated one woman. Another woman, in need of regular and specialized care for a heart murmur, regularly did not access care: “If you’re talking about our people [First Nations], they need safe transportation. Not having a reliable ride [means] missing a lot of appointments.” Although doing so was dangerous, participants overcame physical distances. More challenging was the social distancing they faced when leaving places imagined and constructed as always peripheral by broader, off-reserve, non-Indigenous society.

### Reserves and Racialization

First Nations in northern interior British Columbia are unequivocally remote and rural by provincial and national standards. Unlike non-Indigenous peoples who live remotely, being an on-reserve Indigenous person and leaving one’s community means crossing the spatial and legal boundaries of the colonially constructed Indian reserve. Reserve spaces are literally and discursively cordoned off from the rest of the province. Living on an Indian reserve in northern interior British Columbia means being bound—materially and imaginarily—to an othered territory. Leaving that territory means being socially and territorially out of place. Participants sensed that their identities, anchored inextricably and legislatively to being a Status Indian from the uniquely demarcated space of an In-

dian reserve, are almost always judged negatively when interacting with the health care system:

I just want to feel welcomed. When we go to the different places [emergency rooms and hospitals], we’re kind of judged. I want to be taken seriously and not judged because we’re Native. . . . Each Native person [from my reserve], when they go to the hospital in town, they bring this form [indicating being Status] and they have to get it stamped with a time and a date and everything. It looks like [the intake nurse] gets pretty annoyed with those forms. It’s more work for her. She looks pretty cranky.

Being First Nations from a reserve, who, by necessity, steps out of place to access health care, requires overcoming significant physical distancing and remote geographies. This results in a social distancing whereby one’s status—which easily translates into “race”—becomes immediately visible. Participants experienced active racialization based on being from, and leaving, the constructed spaces of Indian reserves:

You have to go into town for emergencies and everything. With us out here, you either [have to] hitchhike or pay people to bring you into town. Lots of times, when you ask [a non-Native] for a ride, they don’t want to give you a ride. They look [at you] and think “This Indian’s a druggie . . . or a drunk.” If you stick a camera in that medical building [in the city], you could see it. I spend my whole day getting into town to get treated like shit. . . . [Doctors should be] concerned no matter what color the person is.

Somewhat paradoxically, the majority (more than thirty-two) of participants expressed deep feelings of trust toward what was often referred to as *Needo* (Dakelh for Whiteman) medicine and simultaneously spoke about racism when they visited health care service sites. They believed and trusted that more abstract and placeless scientific research would positively impact their health. They were often uncomfortable, however, interacting with place-specific expressions of the health care system (e.g., hospitals, doctors’ offices, clinics, and pharmacies), believing that professionals therein equated being from an Indian reserve with being a particular kind of person:

I’d like people to know that just because we’re Indians, we’re not a lower life form. Which is really what you get [in the city, off-reserve]. It’s a fact of life, we all know it. We try to avoid going into town, to the hospital or anywhere because [we] can’t stand being treated with such a condescending manner. It just makes me mad, so I just don’t bother.

In describing her two children's negative experiences with the hospital in a city 400 km away from her reserve, one woman stated simply, "The medical system and the hospital are racist. My daughter once ended up there because of a seizure. They asked if she drank. She said 'Yup, I had one beer.' As soon as she said that, they discharged her. And my daughter is not a drinker." When asked what would make her more comfortable in that hospital, she replied "a new attitude toward Native people."

The conflation of living on reserve with stereotypes about being a certain kind of person (a drunk, poor, backward, hostile to medical advancements, and uneducated "Indian") was mentioned by more than one quarter of participants. Where a person lived, according to participants, immediately results in being racialized: "I took my cousin with chest pains into a doctor [off-reserve]. The nurse asked 'How many drinks have you had?' Automatically. My cousin doesn't even drink and she was automatically asked that. That's totally racist. Just because you're Native [from a reserve], they automatically think that you're drinking." As stories about racialized encounters travel, they impact peoples' perceptions about the health care system, independent of direct experience. One participant, who "wasn't sure [she'd personally] had bad experiences" with the health care system, nevertheless observed: "There's one Elder . . . he says to everybody that [the reason] Aboriginal people are dying off quickly is because of the hospital. Because we're not treated right. I really believe that." For some participants, the health care system is tantamount to some of the most egregious historic colonial practices: "It's another way of destroying our people. Same thing as residential school. . . ."

### Uncommon Ground

Participants avoided homogenous definitions of Indigenous health practices. Many, however, suggested that integrating elements of "Indian medicine" into off-reserve *Needo* health systems could result in First Nations feeling more welcomed, despite being far away from their communities and thus, automatically, out of place. Language was central to these considerations, itself a form of "Indian medicine" and a literal utterance of culture and health. When an Indigenous language was not spoken, the situation was immediately unhealthy. A fifty-three-year-old Wet'suet'en woman who came "from a long line of traditional leaders" explained the challenges of accompanying an elder to the hospital:

He suffers from high blood pressure. The doctor was attempting to explain and I couldn't explain it to him in Wet'suet'en, which if someone would have interpreted it for him, he would have gotten. [Non-Native doctors] need to be more accepting of our ways. Start listening. I wish they could hire more people that speak our language.

Off-reserve health care spaces, for many participants, were expressions of colonialism designed to expand previous efforts of eradicating Indigenous systems of knowledge, including First Nations' medical knowledge. Not being able to discuss medicines and practices still actively used in their reserves added to some participants' beliefs that their ways of being were still actively under attack:

Go back to the beginning. Look at Canada and British Columbia. They came in here with their western law. We've become wards of Canada. They think they're going to protect us . . . they put down reserves . . . they say we're part of the western system. [Now] the whole hospital system is [that] system. We got no trust to follow it. Because our culture is different. To me, when I look at the medicine we make, it's a gift. But [that concept] is not valued.

In addition to integrating and valuing Indigenous languages and cultures within all aspects of health care provision, participants offered a number of other solutions. Increasing the number of Native doctors and health care professionals, who were seen by some participants as "understanding two worlds," and purposefully educating non-Indigenous health care professionals about Indigenous peoples—particularly their histories and the places where they lived—were all suggestions for overcoming the divisions experienced by First Nations from northern interior British Columbia.

### Conclusions

Health and well-being are increasingly conceptualized as socially determined and as deeply affected by access, or lack of access, to systems of health care, which, in turn, reflect various hierarchies of social, cultural, political, and economic power. Social determinants of health and health care systems are geographical; they take place somewhere, shift and change according to their spatial and temporal contexts, and are altered by their geographic confines and geographies of power. If poor health is an outcome of poor social determinants and disconnect with health care systems, it is also an outcome of the physical and social geographies that shape and determine those social determinants and health care systems. Participants in this research made

theses linkages clearly, suggesting that their health cannot be fully conceptualized, or improved, without understanding it as geographically contingent and, consequently, as an outcome of long-standing colonial work to spatially, socially, and corporeally dislocate and distance them from non-Indigenous British Columbians.

The 2009 British Columbia Provincial Health Officer's report offers a comprehensive picture of Indigenous peoples' health in the province (see also British Columbia Provincial Health Officer 2002). Since 2001, no substantive changes occurred in thirty-nine of fifty-seven indicators of health and well-being. British Columbia's Indigenous peoples experienced worsening trends in ten of fifty-seven indicators, including increased rates of HIV/AIDS, use of prescription drugs, poor housing, low birth weights, and the number of children who live as governmental wards (see also Hughes 2006; Blackstock 2007; de Leeuw, Greenwood, and Cameron 2010). Since 1992 Status Indian men maintained the lowest life expectancy of any group in the province, dying almost ten years earlier than non-Indigenous women, the people who live longest in the province. Status Indian women die over a year earlier than non-Indigenous men in the province and the gap between the two groups has widened by over a year in the last fifteen years.

These data capture health disparities between different peoples in different places, but neither physical nor social geography are explicitly theorized as determinants of health. For a significant number of First Nations in northern interior British Columbia, however, their Indian reserves and homeplaces, to which they were and continue to be confined, are inextricably linked to being, or not being, healthy. The health of First Nations living on reserves is determined by physical geographies (e.g., distance from services) but, even more difficult to overcome, by socio-imaginative geographies that racialize people precisely based on being from an Indian reserve. This place-based racialization determines whether First Nations access the health care system and how, if they do, they are treated once within the system. Too often, an experience of geographically linked racialization extends beyond interactions with the health care system; distance from an array of services and deep poverty in reserves demand that many First Nations leave their communities to access other services or find employment, both of which figure into peoples' overall health and well-being. Leaving the colonially produced spaces of Indian reserves also means leaving support structures that result from being in place, including understandings about

Indigenous languages and cultures, resulting in reduced resiliency against racialization. This, too, becomes a factor in being, or not being, healthy. Understanding disparities between Indigenous and non-Indigenous people's health means understanding those disparities as geographically expressed and determined. Accounting for racializations linked to colonial geographies is thus paramount in ameliorating the enduring and unequal health disparities lived by Indigenous peoples.

## Notes

1. Canada's constitution recognizes unique relations with three distinct groups of peoples: First Nations, Inuit, and Métis. "Indian" is a problematic misnaming of these Indigenous peoples used herein for historical accuracy only.
2. In accordance with ethical standards of research with Indigenous people, communities had an opportunity to consider drafts of this research. Lee Edmond is not a pseudonym, fictitious character, or composite: It is the real name of a young man who insisted on his name appearing in this article.
3. According to the Provincial Health Officer's report published in 2009, deaths from "unintentional injuries" account for 8.5 deaths per 10,000 Status Indians in northern interior British Columbia, more than double the rate (4.2) of other residents in the region and over three times higher (2.6) than other residents across British Columbia. Mortality rates from unintentional injuries for Status Indians in northern interior British Columbia are also higher than those of Status Indians across the province as a whole (7.3 per 10,000).
4. The government of Canada distinguishes between registered (or Status) and nonregistered (or non-Status) Indians. For further reading on these very complicated divisions, and resultant impacts, see de Leeuw and Greenwood (2011) and Aboriginal Affairs and Northern Development Canada's (2010) "You Wanted to Know: Federal Programs and Services for Registered Indians."
5. This highway, Highway 16, is known nationally as The Highway of Tears.
6. Data are age-standardized for mortality rates.

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